**SUSTAINABILITY AND
ENVIRONMENTAL GROUP**

CULTURAL RESOURCE PREDICTIVE MODELING

**ABERDEEN TEST CENTER
DUGWAY PROVING GROUND
REAGAN TEST SITE
REDSTONE TEST CENTER
WHITE SANDS MISSILE RANGE
YUMA PROVING GROUND**

**NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
NAVAL AIR WARFARE CENTER WEAPONS DIVISION
NAVAL UNDERSEA WARFARE CENTER DIVISION, KEYPORT
NAVAL UNDERSEA WARFARE CENTER DIVISION, NEWPORT
PACIFIC MISSILE RANGE FACILITY**

**30TH SPACE WING
45TH SPACE WING
96TH TEST WING
412TH TEST WING
ARNOLD ENGINEERING DEVELOPMENT COMPLEX**

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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CULTURAL RESOURCE PREDICTIVE MODELING

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Prepared by

**Sustainability and Environmental Group
Range Commanders Council**

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U.S. Army White Sands Missile Range
New Mexico 88002-5110**

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Preface

This document was prepared by the Sustainability and Environmental Group under the Range Commanders Council. All member ranges are in different stages of having or using Cultural Resource Predictive Modeling. This document surveyed the range members to determine what level was being used. The ultimate goal is to have a compliant cultural resource program and provide support to the test ranges for their missions. This document will provide information such as lessons learned, points of contact, and resources to the range cultural resource managers.

Objective/Scope: Identify existing cultural resource predictive models and lessons learned from predictive modeling. Provide a list of points of contact.

Deliverable: Report outlining what cultural resource predictive modeling is, including benefits and limitations; list of models that currently exist, including benefits and limitations; lessons learned from previous predictive modeling efforts; and subject matter experts at member ranges.

Benefit: Virtually every member range has cultural resources (CRs) on the range. Predicting the location of CRs would benefit the range user when planning future test programs. Cultural resource predictive modeling is rather complex. When faced with the challenges, this document would accelerate the timeline for member ranges.

Please direct any questions about this document to the RCC Secretariat.

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Acronyms

AFB	Air Force Base
ACDC	Archaeological Cultural Database Compilation
AUTEC	Atlantic Underwater Test and Evaluation Center
BMGR-E	Barry M. Goldwater Range East
CR	cultural resource
CRM	cultural resource management
CRPM	Cultural Resource Predictive Modeling
DoD	Department of Defense
ESTCP	Environmental Security Technology Certification Program
GIS	geographic information system
MRTFB	Major Range and Test Facility Base
NAVAIR	Naval Air Warfare Center
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
PA	Programmatic Agreement
POC	point of contact
RCC	Range Commanders Council
SEG	Sustainability and Environmental Group
SHPO	State Historic Preservation Office
SSU	sample survey unit
THPO	Tribal Historic Preservation Office

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CHAPTER 1

Background

1.1 Range Commanders Council Sustainability and Environmental Group

The mission of the Range Commanders Council (RCC) is to serve "the technical and operational needs of the United States (U.S.) test, training, and operational ranges." The Sustainability and Environmental Group (SEG), one of many RCC working groups, was formed in 2012 when the Sustainability Group and Range Environmental Group were merged. The SEG's goal is to monitor and address sustainability, encroachment, environmental, and community outreach issues affecting the test, training, and operational ranges.

The SEG meets twice a year to review and discuss the latest issues affecting the ability of member ranges to sustain their missions and shares tools for proactively addressing those concerns. The SEG focuses on environmental management and compliance, land use, outreach, air and sea space encroachment, and other sustainability areas. The SEG shares trends and approaches used to protect the military mission and recommends solutions to commanders.

Meetings are interactive and open to ranges and installations throughout the U.S. and are not limited to Major Range and Test Facility Base (MRTFB) installations. Entities both inside and outside the Department of Defense (DoD) with common interests in environmental, sustainability, encroachment, and community outreach solutions are welcome to attend.

1.2 Introduction

The DoD is obligated under Sections 106 and 110 of the National Historic Preservation Act (NHPA) of 1966, as amended[1], to identify cultural resources (CRs) significant to our national heritage and to take appropriate steps toward preserving and protecting those resources. Under the National Environmental Policy Act (NEPA)[2], the DoD is also required to involve stakeholders in environmental planning processes.

These obligations are met by evaluating the environmental impacts of potential undertakings, proposing project alternatives, soliciting input from stakeholders through an open and transparent consultation process, and, if necessary, mitigating any adverse effects an undertaking would have on historic properties.

To fulfill cultural resource management (CRM) legal obligations under NEPA and the NHPA, military installations need to demonstrate that CRM decisions are based on objective and replicable information on the distribution and significance of archaeological sites under their jurisdiction.

The DoD has long taken a conservative approach to these legal mandates, with the agency's stated goal being to inventory all military holdings and evaluate all discovered archaeological sites. However laudable, these goals are unrealistic with current and future funding/staffing levels.

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[1] National Historic Preservation Act of 1966, as amended, 16 U.S.C. § 470 et. seq. (last amended 2014).
[2] National Environmental Policy Act as amended. 42 U.S.C. 4321 et seq.

1.3   What is Cultural Resource Predictive Modeling (CRPM)?

Archaeological predictive models use prior knowledge to predict the expected nature and distribution of the archaeological record.

There is no one kind of predictive model, although the military has many models designed to predict the location of sites discovered through conventional survey techniques. Note: models are built for areas needed, topographical considerations, and type of CR.

In addition to predicting site location, models can be constructed to predict archaeological data quality, significance, the potential of encountering buried sites, and other features important to the management of CRs on military lands.

The CRPM process relies on using prior knowledge already gained about the archaeological record.

Verification of models through ground survey needs to be part of the process to ensure accuracy of the predictive modeling.

The Environmental Security Technology Certification Program (ESTCP) project illustrated that there is no single kind of model that each installation needs (i.e., a locational model for all sites discovered through conventional survey methods) but that modeling should suit current and anticipated management needs in a flexible manner (Green et al., 2012).[3]

1.4   Lessons Learned from Strategic Environmental Research and Development Program/ESTCP CRPM Projects

The completion of this task assignment (RCC SEG-002) required identifying existing DoD cultural resource predictive models and the lessons learned from the development and use of these various models across a variety of military installations.

A goal of this assessment was to identify the benefits and limitations of existing DoD models through a questionnaire survey of CR subject matter experts and what has been learned from previous efforts. The survey results showed that an assortment of different models of varying complexity is used by the nine ranges that have predictive models, and that further refinement and development of them is required. Additionally, it should be noted that the survey did not elicit clear-enough responses from the member ranges on which the RCC would be able to draw any definitive conclusions about predictive modeling.

Over the course of this task assignment, research discovered that a number of attempts at CRPM have been conducted over the years at various DoD installations that indicate a core set of issues related to the usefulness of these models and the inherent difficulties in their development. The study by Green, et al., entitled *Integrating Archaeological Modeling in DoD Cultural Resource Compliance*, illustrates this point. This extensive five-year research effort into the utility of predictive modeling was conducted by the ESTCP and was built off of seven years of legacy-funded work that "was designed to validate models and demonstrate their potential for streamlining and economizing compliance and improving asset management" (Green et al.,

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[3] Green, Paul R. et al. *Integrating Archaeological Modeling in DoD Cultural Resource Compliance*. Project RC-200720. Version 3.0. 26 October 2012. May be superseded by update. Retrieved 4 May 2017. Available at http://www.dtic.mil/dtic/tr/fulltext/u2/a571270.pdf.

2012). This project was sponsored by the US Air Force Civil Engineering Center and the US Army Corp of Engineers.

As Green et al. revealed, and which the RCC questionnaire survey and our research corroborates, the core issues related to predictive modeling are relatively consistent across the board; however, each installation's situation in creating predictive models is unique due to the archaeological and geographical distinctiveness of each range. As the report states:

> These research products are presented to illustrate the maxim "one size does not fit all," and demonstrate that DoD installations have many different CRM needs that can and should be met through a variety of modeling tools and approaches (Green et al. 2012, xiii).

> Developing predictive models requires a large quantity of CRM and environmental data. Although many installations have compiled some of this data, they often are not readily available in a digital format. Sometimes, in excess of a terabyte of data will need to be transmitted for use in modeling - a constraint which can sometimes pose logistical challenges for an installation. When they are available, digital data may require extensive evaluation for data quality and representativeness. For instance, it is often the case that CRM site attribute data are scattered across multiple databases, tables, and fields, and that the data entered in a given field are recorded as unstandardized comments, making their interpretation difficult (Green et al. 2012, 180).

A common presumption is that predictive models can lessen costs of environmental and CR compliance by eliminating the need to conduct archaeological surveys. While in theory this perspective may appear cost-effective, the reality may be that the up-front costs and time necessary to develop a usable predictive model that could elicit concurrence from state and tribal historic preservation officers and other stakeholders could be more problematic. As the cited study shows, it was a five-year research program based on seven years of legacy data. Development of predictive models requires a long-term commitment in both time and funding in order to create models that are reliable, replicable, and can be improved over time. This is not to say that developing predictive models at RCC member ranges is not feasible, but only to point out that it is a process that entails a great deal of collaboration and consultation with stakeholders to ensure that all concerns are addressed so that Programmatic Agreements (PAs) may be instituted that can streamline Sections 106 and 110 procedures of the NHPA, as well as the requirements of the NEPA.

Future efforts should consider four implementation issues. First, the weakest link in developing and refining formal, inductive predictive models is the quality of the archaeological and environmental data. To build models efficiently, relevant archaeological data should be maintained in computerized databases usable by a geographic information system (GIS). Similarly, environmental data should be of sufficient accuracy and resolution to facilitate the measurement and correlation of site locations with natural features. Second, to efficiently create and test predictive models, modelers and installation staff need to work together early and often to ensure that key variables are included in both the underlying model and the resulting management model. Third, for predictive models to be incorporated into PAs, installation CRM staff must involve their consulting parties (State Historic Preservation Office [SHPO] staff, Native American groups, and other interested parties) from the beginning of the modeling

process and maintain regular contact. Consulting parties will need assurance to maintain confidence in the value of modeling for finding and protecting sites as well as enhancing knowledge of past cultural systems. Finally, it is critical to view modeling as a process and not an event; models improve with more data, allowing the DoD to meet its stewardship and mission goals more efficiently and with better results (Green et al. 2012).

CHAPTER 2

Survey

2.1 Survey Questions

Appendix A is a copy of a blank survey questionnaire while Appendix B has copies of the completed surveys. A questionnaire went to all member and associate member ranges on the SEG. There are 18 member ranges and 17 associate members. Because associate members may not be affiliated with an installation that has a range, it is reasonable to not expect all 17 to reply. Fourteen survey questionnaires were returned with five of them as a negative, i.e., no CRPM system used. Below is the breakdown of the ranges that responded.

- Cape Canaveral
- Eglin Air Force Base (AFB) (96th Test Wing)
- Vandenberg AFB (30th Space Wing)
- Naval Undersea Warfare Center Division Newport Atlantic Undersea Test and Evaluation Center (AUTEC) - Negative
- Barry M. Goldwater Range (BMGR)
- NASA Wallops Island
- Aberdeen Test Center
- Naval Air Warfare Center (NAVAIR) Patuxent River (PR)
- Edwards AFB (412th Test Wing)
- White Sands Missile Range
- Pacific Missile Range Facility - Negative
- Naval Undersea Warfare Center Division Keyport - Negative
- NAVAIR China Lake – Negative
- NAVAIR Point Mugu - Negative

2.2 Details of Responses

2.2.1 Cape Canaveral Air Force Station/Patrick AFB (45th Space Wing)

Point of contact (POC) Thomas Penders, 45th Space Wing Cultural Resources Manager, thomas.penders@us.af.mil, DSN 467-0886.

Cape Canaveral does have a CRPM system; however, it is based on current knowledge supported by previous surveys. There are deficiencies in these previous surveys. The model in use is not a computerized program. Cape Canaveral is currently programming a series of archaeological surveys to correct the predictive model over the next six years that includes systematic Phase I testing.

The GIS layers to incorporate are:

- Topographic – Relic dune ridges;

- Soil – Well to excessively drained sandy soils;

- Water – Freshwater swales, freshwater marshes, freshwater lakes/ponds;

- Vegetation – maritime hammocks, oak hammocks, Australian pines and exotics decorative plants for historic sites;

- Social – within 100m of water sources.

The CRPM system has not been validated but is a part of their Integrated Cultural Resource Management Plan (ICRMP), which SHPO has accepted. Cape Canaveral has a good relationship with their SHPO. Only 25% of the installation has been surveyed and the CRPM system includes subsurface testing, geomorphology, and historic models.

Lessons Learned: Predictive models based on surveys at Cape Canaveral from the 1980s and 1990s are inaccurate and were redundant. They only tested where they "KNEW" sites would be located partly from data from the 1960s and earlier. The surveys did not test all the ecosystems and missed a significant freshwater feature on Cape Canaveral (large freshwater lake). Since 2006 various environmental studies have found maritime hammocks that contain prehistoric sites. Previous surveys declared these areas as low-probability zones. While predictive modeling assists in identifying impacts and possible sites, it is only a tool that should be used in any preliminary study and should NEVER replace field studies. Kennedy Space Center is finding this out with previously unrecorded sites being found recently.

2.2.2   Eglin AFB (96th Test Wing)

POC Rhena Lynn Shreve, rhena.shreve.1@us.af.mil, 850-883-2102.

Eglin does have a CRPM system and uses it almost daily. It is GIS-based and was established initially in 1995, then validated in 2012. Eglin has significant layers under topographic, soil, water, and vegetation.

Table 2-1. Eglin AFB Model Predictors	
Resource	Variable
Topographic	% slope
Soils	Distance to soil facies with thick A horizon.
Water	Elevation above potable water, distance to potable water, distance to hydronet junction, stream level, distance to flow accumulation feature, wetland presence/absence, distance to wetland edge, distance to coast.
Vegetation	Vegetation richness, distance to sand pine forest, distance to galberry/saw palmetto shrubland, distance to mixed evergreen-cold deciduous forest, distance to mesic-hydric pine forest, distance to swamp forest ecological complex, distance to loblolly bay forest, distance to xeric-mesic mixed pine/oak ecological complex.

Eglin has 57% of their installation surveyed with 98% of the high-probability areas surveyed, has a PA with SHPO, and has a very good working relationship with them. The model includes subsurface investigation, geomorphology, and historic information.

Lessons Learned: The original model was focused on the identification of prehistoric resources. This shortfall was remedied in the second version, which included data from historic resources such as US Forest Service maps and documents, General Land Office records, early aerial photographs, maps, and local histories to identify early homesteads and industrial sites. The predictive model should not be a stagnate tool, but one that evolves and is improved as technology changes and new information comes to light. These improvements increase the validity of the predictive model as a planning tool for the coordination of mission activities.

2.2.3   Vandenberg AFB (30th Space Wing)

POC Christopher Ryan, christopher.ryan.7@us.af.mil, 805-605-0748.

The following is the response provided by Vandenberg's POC. "Vandenberg does not have a CRPM system but uses predictive modeling informally. For example, there is no probability for buried archaeological deposits on the Burton Mesa, but there is high probability for buried deposits in river valleys. That is something I understand based on my professional knowledge about geology, geomorphology, and geoarchaeology, as well as my experience with excavations on the various regions of the base. I don't have one because I have never asked for funding for one, because I don't really need one. We have a base-wide survey, so we know where the surface sites are, and I intuitively understand where the subsurface sites will likely exist."

2.2.4   Naval Undersea Warfare Center Detachment AUTEC

POC Marc Ciminello, marc.ciminello@autec.navy.mil, 561-671-2612.

There are minor Bahamian archaeological resources at AUTEC site 4 on Golding Cay. The Bahamian archeological resources have been surveyed and an inventory has been provided to the appropriate Bahamian Ministry; therefore, there is no need for a CRPM system.

2.2.5   Barry M. Goldwater Range-East (BMGR-E)

POC Adrianne Rankin, adrianne.rankin@us.af.mil, 623-856-8410.

The BMGR-E range does not have a CRPM system but is exploring how they can use the data collected during the Section 110 work to develop a comprehensive and representative understanding of the archaeology of the BMGR-E. The software they will be using is ArcGIS 10.3; R statistical package 3.2.3; Archaeological Cultural Database Compilation (ACDC) v2 database; Microsoft Access 2007; Environmental Systems Research Institute; and Statistical Research, Inc. The strategy is to use ACDC v2 to organize sites into types according to function, chronology, and condition. The Luke AFB Range Management Office GIS data will be used along with environmental strata to develop model training and test samples, according to site type and modeling unit. Survey has recently been completed in upland areas of the BMGR-E, providing important data in underrepresented environmental zones. A healthy list of model predictors will be used, as shown in Table 2-2.

Table 2-2. BMGR-E Model Predictors

Resource	Variable
Topographic	Shelter, relief, surface roughness/texture, aspect, slope/slope length, elevation-standardized height/height above channel.
Soil	Soil texture, depth to restrictive layer, CaCO3 content, organic matter content/ A Horizon thickness, erosion potential (k factor, Erosion/Deposition Model), available water capacity.
Water	Cost distance to drainage (major and minor), cost distance to Gila river, cost distance to Adair Bay, cost distance to springs/tinajas, flow accumulation historic rainfall averages.
Vegetation	Vegetation diversity within 1 km, vegetation type, surface visibility.
Social	Shell trade routes, cost distance to lithic source materials (e.g., obsidian), least cost paths among major sites and resource zones.

The BMGR-E range has about 18% of the range surveyed and has a good relationship with SHPO. They are using the report *Pathways to Preservation: A Research Design and Heritage Management Plan for the Barry M. Goldwater Range, East* to implement CRPM since they are just starting this process.

Lessons Learned: The contractor in developing these tools, SRI, has learned that sampling areas that are not directly affected by training or development can be very important to building effective models. Moreover, performing subsurface testing and data recovery is important to understanding and modeling site condition, significance, and integrity. When developing programmatic approaches to site and landscape management, CRPM is an important component, and the 56 RMO/ESM is moving toward a programmatic approach.

2.2.6 NASA Wallops Flight Facility

POC Shari Miller and Randy Stanley, shari.a.miller@nasa.gov and randall.m.stanley@nasa.gov. 757-824-2327 and 757-824-1309 respectively.

Wallops does have cultural properties to manage and does have a CRPM system but has only used it once. Wallops has based it off of the document *Final Cultural Resource Assessment of Wallops Flight Facility, Accomack County Virginia*.[4] They have established a PA with the Virginia SHPO and the Advisory Council on Historic Preservation that incorporates verifying the model through a Phase I assessment.

Model predictors are as follows (URS and EG&G 2003 p. 5-48).

> The above model describes areas of moderate and high sensitivity for prehistoric archaeological resources. Low archaeological sensitivity areas include any of the following characteristics: poorly-drained soils (during prehistory); slopes greater than 10 percent; distances greater than 160 meters (500 feet) from water; and severe disturbance from modern activities, such as

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[4] URS Group and EG&G Technical Services, Inc. *Final Cultural Resource Assessment of Wallops Flight Facility, Accomack County Virginia*. November 2003. Retrieved 30 August 2017. Available at https://sites.wff.nasa.gov/code250/docs/Cultural%20Resources%20Assessment.pdf.

construction and earth-moving. The predictive model for prehistoric site locations within the current project area is summarized in Table 5-2.

Table 5-2. Prehistoric Site Predictive Model for the Project Area

Sensitivity	Landform	Soil Drainage Type	Slope	Distance to
Low	tidal marsh, topographically low areas	poorly-drained	< 2 %	n/a
	terrace, knoll, ridge, and bluff edges	all types	> 10 %	n/a
	terrace, knoll, ridge, bluff	all types	n/a	> 160 meters (> 500 feet)
Moderate	terrace, knoll, ridge, bluff, barrier island	moderately-drained	2 – 10 %	< 160 meters (< 500 feet)
High	terrace, knoll, ridge, bluff, barrier island	well-drained	2 – 10 %	< 160 meters (< 500 feet)
	hummock or knoll in tidal marsh	moderately- to well-drained	2 – 10 %	n/a

The same document later (p. 5-51) provides a more thorough description of the models.

The predictive models for historic site locations within the current project area are summarized in Tables 5-4 and 5-5.

Table 5-4. Non-Maritime Historic Site Predictive Model for the Project Area

Sensitivity	Landform	Soil Drainage Type	Slope	Distance to
Low	tidal marsh	poorly-drained	< 2 %	0
	terrace or bluff edge	all types	> 20 %	> 15 meters (> 50 feet)
Moderate	terrace, ridge, knoll	moderately to well-drained	10 – 20 %	n/a
High (all site types except mills)	terrace, ridge, knoll	well-drained	2 – 10 %	< 300 meters (< 900 feet)
High (mills only)	terrace or bluff edge adjacent to freshwater source	n/a	> 20 %	0

Domestic sites and cemeteries, as well as commercial and industrial sites such as taverns, tanneries, and mills, are included in the non-maritime sites. Low archaeological sensitivity areas include severe disturbance from modern activities, such as construction and earth-moving.

Table 5-5. Maritime Historic Site Predictive Model for the Project Area

Sensitivity	Landform	Soil Drainage Type	Slope	Distance to water
Low	terrace	all types	n/a	> 30 meters (> 100 feet)
Moderate	shoreline, tidal marsh, barrier island	poorly to moderately-drained	n/a	n/a
High (domestic*)	barrier island	well-drained	> 2 % and < 10 %	< 30 meters (< 100 feet)
High (other than domestic)	barrier island, beach shoreline, tidal marsh	poorly to well-drained	n/a	< 30 meters (< 100 feet)

Note: Maritime sites include domestic sites such as fishing village communities

The model has been validated on a project-specific basis only; i.e., if a project proposes to break ground in an area of increased sensitivity, a Phase I assessment is first performed. The CRPM system has been included in the PA and Wallops has a very good working relationship with SHPO.

Lessons Learned: There is a dig request process at NASA WFF for any ground-breaking activities. The SHPO and staff are tied into this process and can quickly determine if a proposal would occur in modelled areas. Additionally, all cultural sensitivity layers have been added to the GIS FlexFinal and are available to all program managers to reference. Having the SHPO's buy-in on the model made it much easier to get concurrence on the PA.

2.2.7 Aberdeen Test Center

POC mark.t.gallihue.civ@mail.mil.

Aberdeen does have CR properties to manage but does not have a formal CRPM system at the installation. A study from the 1990s developed a pseudo-model that is still in use. That study produced GIS layers that show cemeteries, high-potential archeological areas, known disturbed archeological areas, locally disturbed archeological areas, historic districts, archeological sites, and historic ruins. The layers are interpreted along with other topographical features, such as distance to water, to make determinations on potential for CRs. This system has not been formally approved by the SHPO, but works well for management. Relationship with SHPO at Aberdeen is good to very good. One barrier to a computer model would be obtaining a certificate of net-worthiness from the Network Enterprise Center.

2.2.8 NAVAIR PR

POC Michael A. Smolek, Cultural Resources Program Manager, michael.a.smolek@navy.mil, 301-757-4774.

The NAVAIR PR facility does have CR properties to manage but does not have a CRPM system. A predictive model for prehistoric archaeological resources was developed in 2003 for the main base (6500 acres). Since that time approximately 90% of the surveyable terrestrial areas of the NAVAIR PR complex (some 20,000 acres) have been surveyed. The areas of the water ranges have not been systematically surveyed. The model was developed before the current CRM was employed here. Table 2-3 displays the model predictors.

Table 2-3.	NAVAIR PR Model Predictors
Resource	Variable
Topographic	Soils, proximity to water, elevation, slope, aspect.
Soil	Existing sites were correlated with six different soil types as defined by county soil conservation service mapping, which considers many variables to define soil type.
Water	Greater or less than 400 feet from water (fresh and brackish).
Vegetation	Not considered.
Social	Not considered because not relevant in coastal plain environment with plentiful water and few barriers.

The NAVAIR-PR POC stated that SHPO does not have any faith in the predictive models at this time but does have a very good relationship with SHPO.

Lessons Learned: If there is an undertaking proposed in an unsurveyed area, generally a survey is required, model or no model. So while the model may be useful in some situations, it is not particularly useful in this situation. The model also only deals with Native American archaeological sites, so the 350+ years of historic period Euro-American occupation is not considered and, in any case, is more difficult to model. The model does not deal with the huge areas of the Chesapeake Bay or Atlantic Ranges, which are water ranges with the potential for historic and prehistoric sites.

2.2.9   Edwards AFB (412th Test Wing)

POC Roscoe Loetzerich, roscoe.loetzeric.1@us.af.mil, 661-277-1413.

Edwards does have CR properties to manage and does have a CRPM system and only uses it about one time per year. It is based on ArcGIS, version 10.3. The strategy is for a stratified random sample of 460 ¼ sections located in the southwest quarter of each one-square-mile section on Edwards AFB. The number and quantity of acreage per sample survey unit (SSU) (1/4 square mile) is known across the entire base allowing the base archaeologist to interpolate the number or sites or the acres of site per adjoining area to an SSU.

Edwards uses GIS layers such as archaeological, site features, and sample survey features. The CRPM system has not been validated, is not in the PA, and has not been concurred on by SHPO. Edwards has a working relationship with SHPO. Approximately 70% of the installation has been surveyed.

Lessons Learned: Predictive modeling based on environmental variables (landforms, distance to water source, slope, aspect, vegetation, etc.) is useful for bases with very large tracts of land with a high degree of environmental heterogeneity. Obviously the more similar the environment is across the base with no major differences in vegetation, soil types, etc., the less beneficial a predictive model will be. Edwards AFB is by and large a fairly homogenous base. Furthermore, while the base has current environmental data, it lacks GIS layers that represent soil, vegetation, or hydrographical layers for the recent and distant past, making predictions of site types for specified periods of time in relation to environmental variables basically impossible to determine.

Recognizing this shortcoming, it was decided to focus on the physical archaeological survey of the base. A five-year project was launched in 1999 to conduct a 25% sample of the base, resulting in the survey of the southwest quarter of each one-square-mile United States Geological Survey section across the base. From this data it is possible to estimate the number of acres of archaeological site between the ¼ mile quarter sections.

The CR program is well into its 3rd decade of existence. Hundreds of federal undertakings have resulted in additional surveys being performed so that currently approximately 70% of the base has been inventoried for archaeological resources. This wealth of survey data is often consulted in those cases where a need exists to predict the potential to encounter an archaeological site in a previously uninvestigated portion of the base.

If a graphic is needed to demonstrate the predicted density of archaeological sites in an area, this is most commonly achieved by creating a density map. The density map is calculated by establishing a point at the center of each of the SSUs. The total acreage of archaeological site is calculated for the unit and the number is associated with the center point. The ArcGIS software includes a tool to generate contour lines based on the value of each center point. The ArcGIS technician then enters the number of contour lines to generate between values. The area between the contour lines essentially represents the expected acreage, expressed as a range, of archaeological site to expect within that band.

This is a very straight-forward and simple model, but it is based on reliable data and commensurate with the environment found at Edwards AFB. Given the large body of data currently available there is no limit to the number of academic models that could be developed, but they are not an immediate requirement for the day-to-day management of the resource. That said, the base is always interested in pursuing or supporting models that can help explain the archaeological sites and their distribution across the base.

2.2.10 White Sands Missile Range

POC Jim Bowman, james.e.bowman68.civ@mail.mil, 575-678-7925.

White Sands has CR properties to manage and does have a CRPM system. It is used about two times per year and uses ArcGIS and SRI. It was implemented in 2001.

The model predictors are listed in Table 2-4.

Table 2-4.	White Sands Missile Range Model Predictors
Resource	Variable
Topographic	Slope: 1) Cost Surface - relative cost of moving across landscape; 2) Aspect – direction in which a slope is facing, terrain roughness/surface texture; 3) Shelter - degree to which topographic features afford shelter, cost distance to uplands.
Soils	Soil Survey – organic matter, available water capacity, bulk density, etc.
Water	Landscape features that could have provided surface water resources after precipitation episodes: 1) distance to tanks-location of artificial tanks for water storage; 2) distance to streamlines-distance to drainages, elevation relative to water.
Vegetation	Data from gap analysis program and national land cover data program.

Social	Calculation of least cost path for water

The CRPM system has not been included in the PA and SHPO has not concurred on it. White Sands has a very good working relationship with SHPO. Out of 2.2 million acres, only 28% of the installation has been surveyed.

Lessons Learned: It works well on inaccessible areas where survey can be focused on a sample of areas. It is only for areas that are in the basin; additional data layers for the mountain slopes would be necessary if the capability was to be expanded.

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CHAPTER 3

Conclusion

3.1   Summary

While CRPM is an on-going process that can be utilized by ranges as a planning tool that can assist in compliance with historic preservation laws, it cannot completely replace the need to conduct Section 106 and Section 110 surveys. Realistic objectives for predictive modeling must consider that they require a long-term commitment. These commitments are in terms of time, cost, and future maintenance as new data becomes available to refine the models.

The biggest hurdles facing predictive modeling are not technological; they are sociological. Predictive models have been used in CRM for more than 30 years. Most agencies have tried to use models to lessen the amount of inventory by arguing that survey is not needed in low-sensitivity areas. The backlash led by tribes, SHPOs, and other archaeologists was swift. They argued that not enough is known to have confidence in models and that sites will inevitably be lost. Many stakeholders remain skeptical of both models and government agency motives in promoting models. It would be a mistake for the DoD as a federal agency or a military installation to decide on its own to incorporate predictive modeling in its CRM compliance. Such a move would feed into the skepticism that SHPOs, tribes, and others already have toward predictive modeling. The best way to move forward is to make predictive modeling a joint effort from the very beginning. Fort Drum is a case in point. Prior to the ESTCP demonstration project (Green et al., 2012), the New York SHPO was strongly opposed to predictive modeling. Before initiating the demonstration project, the team met with SHPO representatives and discussed the latter's concerns, how to meet them, and how to move forward. The project team provided the SHPO with a demonstration of the model and was in regular contact with them as the PA was drafted. The consultation required considerable effort. The SEG are convinced, however, that without this effort, no model, regardless of how accurate and powerful, would have allayed SHPO concerns and that a programmatic approach could not be successfully implemented.

The ultimate goal of predictive modeling is not, as some may claim, to lower costs. The ultimate goal is to make the best decision about archaeological resources in the most efficient manner. The SEG strongly believes that good decisions will put the right dollars on the right resources. It will save money because the current situation is highly inefficient. Managers initiate the compliance process for each project as though they and their archaeological contractors know nothing about the installation's archaeology after expending millions of dollars and nearly 50 years of effort. The truth is the SEG knows quite a lot, as you can see from the surveys taken throughout the DoD's MRTFBs. The surveys show that there are various levels of use but a way to manage CRs throughout the DoD. The problem is presenting that information in a way that others can readily understand and that allows all parties to come to a reasonable solution. That is the promise of predictive modeling (Green et al., 2012).

3.2   Recommendation

The Strategic Environmental Research and Development Program/ESTCP already performed an incredible amount of research in the field of CRPM. Their final report (Green et al., 2012) provides detailed information on how to use CRPM as well as the experiences while trying the process on five installations. Rather than the end-all be-all solution to management,

CRPM is only a tool to assist in the management of CRs on the installation. It still takes dedicated resources to implement this type of program and requires proactive coordination with the local SHPO and tribes in order for stakeholder buy-in.

This report in not recommending that CRPM is the only way to proceed to have a viable CR program. The installation needs to make that decision depending on SHPO, stakeholders, funding resources, and the site-specific CRs it manages. Installations are not funded evenly across the board. Some installations have 100% surveyed lands; therefore, modeling is not necessary. If getting 100% survey does not look like an option, CRPM is one way to apply what has been surveyed and put into a model. It would be beneficial to fund the MRTFBs that are lacking the resources to have a good baseline of surveyed areas in order to pursue CRPM. Having this lack of data on MRTFBs slows down the approval process for customers wanting to test.

Development of predictive models requires a long-term commitment in both time and funding in order to create models that are reliable, replicable, and can be improved over time. Buy-in from stakeholders is also important before proceeding down the CRPM path.

Appendix A

Survey

Cultural Resource Predictive Modeling (CRPM) Survey
Sustainability and Environmental Group (SEG) Task-002
Range Commanders Council 2016

Installation Name: _____

Address: _____

Person filing out survey form POC: _____

Email: _____Phone: _____

1) Do you have Cultural Resource property to manage?

   a. Yes
   b. No (If No, survey complete)

2) Do you use CRPM (Cultural Resource Predictive Modeling)

   a. Yes   How Often:
   b. No (If No, please explain why you don't have one. Would you like to have one? Is there a shortage of resources? Do you not need CRPM?) (You are done with the survey if you answered "No".)

3) What is the Program Name:

   a. Software version:
   b. Date implemented:
   c. Software Architect:

4) Subject Matter Expert (SME) for CRPM implementation/use.

   a. Name:
   b. Position:

5) Has a "Sampling Plan/Strategy" been used for model? (Prescribed burns for instance)

   a. Yes, describe:

      _____
      _____
      _____
   b. No

6) Model Predictors (reference only)

   a. Topographic Variables: (GIS Layers)

      i. _____
          _____
      ii. _____
          _____

iii. _____
   _____

iv. _____
   _____

v. _____
   _____

vi. _____
   _____

b. Soil-Attribute Variables: (GIS Layers)

   i. _____
      _____

   ii. _____
      _____

   iii. _____
      _____

   iv. _____
      _____

c. Water Resource Variables: (GIS Layers)

   i. _____
      _____

   ii. _____
      _____

   iii. _____
      _____

   iv. _____
      _____

   v. _____
      _____

d. Vegetation Variables: (GIS Layers)

   i. _____
      _____

   ii. _____
      _____

   iii. _____
      _____

   iv. _____
      _____

e. Social Factors: "Least Cost Path" to water resource for instance. (GIS Layers)

   i. _____
      _____

   ii. _____
      _____

      iii. _____

             _____

7) Has the CRPM been validated?

    a. Yes (If yes, please describe process used), include (%) percent accuracy if available.

        _____
        _____
        _____
        _____
        _____
        _____

    b. No

8) Has the CRPM program been included in your Programmatic Agreement (PA)?

    a. Yes
    b. No

9) SHPO concurrence on use?

    a. Yes
    b. No

10) What is the relationship with SHPO?

    a. Very Good
    b. Good
    c. Working
    d. Strained

11) What is the percent of installation currently surveyed?

    a. %:

12) Does the CRPM include any of the following components:

    a. Significance Model: Yes/No

        i. If yes, does it include subsurface testing for site Integrity aspect

        _____
        _____
        _____
        _____

    b. Geomorph Model: Yes/No
    c. Historic Model: Yes/No

13) Lessons Learned: Some ideas to consider: What would you do different? Issues you run into using CRPM? What works best for your cultural resource management program and how do you make it work well with the mission of your installation? What factors make a CRPM a value to the cultural resource program?

A-4

_____
_____
_____
_____
_____
_____
_____
_____
_____

Appendix B

Completed Surveys

The following pages contain all surveys that participants submitted in response to this task.

Cultural Resource Predictive Modeling (CRPM) Survey

Sustainability and Environmental Group (SEG) Task-002

Range Commanders Council 2016

Installation Name: **Cape Canaveral Air Force Station/Patrick Air Force Base**

Address: _____

Person filing out survey form POC: **Thomas Penders**_____

Email: ___thomas.penders@us.af.mil_____Phone: DSN 467-0886

1) **Do you have Cultural Resource property to manage?**
   a. Yes

2) **Do you use CRPM (Cultural Resource Predictive Modeling)**
   a. Yes   How Often: On a regular basis.
   The CRPM is based on current knowledge supported by previous surveys. However, there are deficiencies in the previous surveys. The CRPM in use is NOT a computerized program.

3) **What is the Program Name:**
   a. Software version: NA
   b. Date implemented: NA
   c. Software Architect: NA

4) **Subject Matter Expert (SME) for CRPM implementation/use.**
   a. Name: Thomas E. Penders
   b. Position: 45 SW Cultural Resources Manager

5) **Has a "Sampling Plan/Strategy" been used for model? (Prescribed burns for instance)**
   a. Yes, describe: We are currently programming a series of archaeological surveys to correct the predictive model over the next 6 years which includes systematic Phase I testing.

6) **Model Predictors (reference only)**
   a. Topographic Variables: (GIS Layers)
      i. Relic Dune Ridges_____
      ii. _____
      _____

      iii. _____

            _____

      iv. _____

            _____

      v. _____

            _____

      vi. _____

            _____

b. Soil-Attribute Variables: (GIS Layers)

      i. Well to Excessively drained sandy soils_____

      ii. _____

            _____

      iii. _____

            _____

      iv. _____

            _____

c. Water Resource Variables: (GIS Layers)

      i. Freshwater swales_____

      ii. Freshwater marshes_____

      iii. Freshwater lakes/ponds_____

      iv. _____

            _____

      v. _____

            _____

d. Vegetation Variables: (GIS Layers)

      i. Maritime Hammocks_____

      ii. Oak Hammocks_____

      iii. Australian Pines and exotics decorative plants for historic sites

    iv. _____

    _____

e. Social Factors: "Least Cost Path" to water resource for instance. (GIS Layers)

    i. <u>Within 100 m of water sources_____</u>

    ii. _____

    _____

    iii. _____

    _____

7) Has the CRPM been validated?

    a. No

8) Has the CRPM program been included in your Programmatic Agreement (PA)?

    a. No

9) SHPO concurrence on use?

    a. Yes. It is in our ICRMP which the SHPO has accepted

10) What is the relationship with SHPO?

    a. Very Good

Cultural Resource Predictive Modeling (CRPM) Survey

Sustainability and Environmental Group (SEG) Task-002

Range Commanders Council 2016

What is the percent of installation currently surveyed?

      b. 25%:

11) **Does the CRPM include any of the following components:**

      a. Significance Model: Yes

            i. Includes subsurface testing for site Integrity aspect

      b. Geomorph Model: Yes

      c. Historic Model: Yes

12) **Lessons Learned:** Some ideas to consider: What would you do different? Issues you run into using CRPM? What works best for your cultural resource management program and how do you make it work well with the mission of your installation? What factors make a CRPM a value to the cultural resource program?

Predictive models based on the 1980s and 1990s surveys at CCAFS are inaccurate and were redundant. They only tested where they "KNEW" sites would be located partly from 1960s and earlier data. The surveys did not test all the ecosystems and missed a significant freshwater feature on CCAFS (large freshwater lake). Since 2006 various environmental studies have found maritime hammocks that contain prehistoric sites. Previous surveys declared these areas as low probability zones. While predictive modelling assists in identifying impacts and possible sites, it is only a tool that should be used in any preliminary study and should NEVER replace field studies. Kennedy Space Center is finding this out with previously unrecorded sites being found recently.

Cultural Resource Predictive Modeling (CRPM) Survey

Sustainability and Environmental Group (SEG) Task-002

Range Commanders Council 2016

Installation Name: _Eglin AFB

_____

**Address:__Valparaiso,_FL_____
_____**

Person filing out survey form POC:

 Rhena L Shreve_(Lynn)_____

Email: rhena.shreve.1@us.af.mil_____

Phone: _850-883-2102_____

1) **Do you have Cultural Resource property to manage?**
   a. Yes X
   b. No (If No, survey complete)

2) **Do you use CRPM (Cultural Resource Predictive Modeling)**
   a. Yes X   How Often: Product used Almost Daily
   b. No (If No, please explain why you don't have one. Would you like to have one? Is there a shortage of resources? Do you not need CRPM?) (You are done with the survey if you answered "No".)

3) **What is the Program Name:**
   a. Software version: GIS/Access
   b. Date implemented: Initially 1995/Validated in 2012
   c. Software Architect: SRI Foundation

4) **Subject Matter Expert (SME) for CRPM implementation/use.**

   a. Name: Jim Wilde

   b. Position: AF CR SME

5) **Has a "Sampling Plan/Strategy" been used for model? (Prescribed burns for instance)**

   a. Yes, describe:__

Cultural Resource Predictive Modeling (CRPM) Survey

Sustainability and Environmental Group (SEG) Task-002

Range Commanders Council 2016

Eglin Zonal Management Model(Sensitivity for cultural deposits), Refined Surface Model(landclaims), Eglin Red Flag Model(archaeological site types) **Model Predictors (reference only)**

b. Topographic Variables: (GIS Layers)

    i.   Elevation above potable water

    ii.   ☐ Distance to potable water

    iii.   ☐ Distance to hydronet junction

    iv.   ☐ Stream level

    v.   ☐ Distance to flow accumulation feature

    vi.   ☐ Wetland presence/absence

    vii.   ☐ Distance to wetland edge

    viii.   ☐ Distance to soil facies with a thick A horizon

    ix.   ☐ Distance to coast

    x.   ☐ Percent slope

    xi.   ☐ Vegetation Richness

    xii.   ☐ Distance to Sand Pine Forest

    xiii.   ☐ Distance to Galberry/Saw Palmetto Shrubland

    xiv.   ☐ Distance to Mixed Evergreen, Cold Deciduous Forest

    xv.   ☐ Distance to Mesic-Hydric Pine Forest

    xvi.   ☐ Distance to Swamp Forest Ecological Complex

    xvii.   ☐ Distance to Loblolly Bay Forest

    xviii.   ☐ Distance to Xeric-Mesic Mixed Pine/Oak Ecological Complex

    xix.   ☐ Percent Sandhill Ecological Complex within 150 m radius

c.

d. Soil-Attribute Variables: (GIS Layers)

    i.   National Hydrography Dataset Plus Data (EPA 2006)

    ii.   ☐ SSURGO Soils Data (NRCS 2009a, 2009b, 2009c)

    iii. ☐ Geospatial Wetlands Digital Data (USFWS 2009)

    iv. ☐National Elevation Dataset Data (Gesch 2007; Gesch et al. 2002)

    v. ☐ National Land Cover Data (USGS, NBII, GAP 2010)

    vi. Most of the variables that were used in modeling were continuous variables

e. Water Resource Variables: (GIS Layers)

    i. Elevation above potable water

    ii. • Distance to potable water

    iii. • Distance to hydronet junction

    iv. • Stream level

    v. • Distance to flow accumulation feature

    vi. • Wetland presence/absence

    vii. • Distance to wetland edge

    viii. Distance to coast

f. Vegetation Variables: (GIS Layers)

    i. Vegetation Richness

    ii. • Distance to Sand Pine Forest

    iii. • Distance to Galberry/Saw Palmetto Shrubland

    iv. • Distance to Mixed Evergreen, Cold Deciduous Forest

    v. • Distance to Mesic-Hydric Pine Forest

    vi. • Distance to Swamp Forest Ecological Complex

    vii. • Distance to Loblolly Bay Forest

    viii. • Distance to Xeric-Mesic Mixed Pine/Oak Ecological Complex

g.

h. Social Factors: "Least Cost Path" to water resource for instance. (GIS Layers)

    i. _____
      _____

    ii. _____
      _____

iii. _____

_____

6) Has the CRPM been validated?

    a. Yes (If yes, please describe process used), include (%) percent accuracy if available.

    ESTCP Final Report   (see Executive Summary)   81%

Has the CRPM program been included in your Programmatic Agreement (PA)?

    b. Yes X

    c. No

7) SHPO concurrence on use?

    a. Yes X

    b. No

8) What is the relationship with SHPO?

    a. Very Good X

    b. Good

    c. Working

    d. Strained

9) **What is the percent of installation currently surveyed?**
   a. %: 98.5

10) **Does the CRPM include any of the following components:**

   a. Significance Model: Yes/No

         i. If yes, does it include subsurface testing for site Integrity aspect

         __yes

         Geomorph Model: Yes

   b. Historic Model: Yes

11) **Lessons Learned:** Some ideas to consider: What would you do different? Issues you run into using CRPM? What works best for your cultural resource management program and how do you make it work well with the mission of your installation? What factors make a CRPM a value to the cultural resource program?

Different

Our First model was geared more towards prehistoric resources we should have included historic properties and sites from the beginning.

Issues

None

Value

We have eliminated a large portion of low probability acreage from survey requirements for Sec 110

We can coordinate with the mission for activities and the model helps us plan.

Cultural Resource Predictive Modeling (CRPM) Survey

Sustainability and Environmental Group (SEG) Task-002

Range Commanders Council 2016

Installation Name: Vandenberg Air Force Base

Address: 30 CES/CEIEA; 1028 Iceland Avenue, Bldg 11146; VAFB, CA 93437

Person filing out survey form POC: Christopher Ryan

Email: christopher.ryan.7@us.af.mil   Phone: 805-605-0748

1) **Do you have Cultural Resource property to manage?**
   a. Yes

2) **Do you use CRPM (Cultural Resource Predictive Modeling)**

   No, but I use predictive modelling informally. For example, there is no probability for buried archaeological deposits on the Burton Mesa, there is high probability for buried deposits in river valleys. That is something I understand based on my professional knowledge about geology, geomorphology, and geoarchaeology, as well as my experience with excavations on the various regions of the base. I don't have one because I have never asked for funding for one, because I don't really need one. We have a base-wide survey, so we know where the surface sites are, and I intuitively understand where the subsurface sites will likely exist.

   (You are done with the survey if you answered "No".)

3) **What is the Program Name:**
   a. Software version:
   b. Date implemented:
   c. Software Architect:

4) **Subject Matter Expert (SME) for CRPM implementation/use.**

   a. Name:

   b. Position:

5) **Has a "Sampling Plan/Strategy" been used for model? (Prescribed burns for instance)**

   a. Yes,

      describe:_____

      _____

_____

_____

_____

    b. No

6) Model Predictors (reference only)

    a. Topographic Variables: (GIS Layers)

        i. _____

          _____

        ii. _____

          _____

        iii. _____

          _____

        iv. _____

          _____

        v. _____

          _____

        vi. _____

          _____

    b. Soil-Attribute Variables: (GIS Layers)

        i. _____

          _____

        ii. _____

          _____

        iii. _____

          _____

        iv. _____

          _____

    c. Water Resource Variables: (GIS Layers)

    i. _____

      _____

    ii. _____

      _____

    iii. _____

      _____

    iv. _____

      _____

    v. _____

      _____

d. Vegetation Variables: (GIS Layers)

    i. _____

      _____

    ii. _____

      _____

    iii. _____

      _____

    iv. _____

      _____

e. Social Factors: "Least Cost Path" to water resource for instance. (GIS Layers)

    i. _____

      _____

    ii. _____

      _____

    iii. _____

      _____

7) Has the CRPM been validated?

    a. Yes (If yes, please describe process used), include (%) percent accuracy if available.

        _____

        _____

        _____

        _____

        _____

        _____

    b. No

8) Has the CRPM program been included in your Programmatic Agreement (PA)?

    a. Yes

    b. No

9) SHPO concurrence on use?

    a. Yes

    b. No

10) What is the relationship with SHPO?

    a. Very Good

    b. Good

    c. Working

    d. Strained

11) What is the percent of installation currently surveyed?
   a. %:

12) Does the CRPM include any of the following components:
   a. Significance Model: Yes/No

       i. If yes, does it include subsurface testing for site Integrity aspect

   _____

   _____

   _____

   _____

   b. Geomorph Model: Yes/No
   c. Historic Model: Yes/No

13) Lessons Learned: Some ideas to consider: What would you do different? Issues you run into using CRPM? What works best for your cultural resource management program and how do you make it work well with the mission of your installation? What factors make a CRPM a value to the cultural resource program?

_____

_____

_____

_____

_____

_____

_____

Cultural Resource Predictive Modeling (CRPM) Survey

Sustainability and Environmental Group (SEG) Task-002

Range Commanders Council 2016

Installation Name: __Naval Undersea Warfare Center Detachment AUTEC_____

Address: ___Mailing Address is PSC 1012 FPO AA Miami, FL 34059_____
_____Physical location is on Andros Island in the Bahamas_____

Person filing out survey form POC: _____Marc Ciminello_____

Email: __marc.ciminello@autec.navy.mil_____ **Phone:** _561-671-2612_____

1) **Do you have Cultural Resource property to manage?**
   a. Yes – Minor Bahamian archeological resources at AUTEC Site 4 on Golding Cay
   b. ~~No (If No, survey complete)~~

2) **Do you use CRPM (Cultural Resource Predictive Modeling)**
   a. ~~Yes~~ ~~How Often:~~
   b. No (If No, please explain why you don't have one. Would you like to have one? Is there a shortage of resources? Do you not need CRPM?) (You are done with the survey if you answered "No".) Bahamian archeological resources have been surveyed and an inventory has been provided to the appropriate Bahamian Ministry. No further action is required.

3) **What is the Program Name:**
   a. Software version:
   b. Date implemented:
   c. Software Architect:

4) **Subject Matter Expert (SME) for CRPM implementation/use.**

   a. Name:

   b. Position:

5) **Has a "Sampling Plan/Strategy" been used for model? (Prescribed burns for instance)**

   a. Yes,

   describe:_____

   _____

   _____

_____

_____

b. No

6) Model Predictors (reference only)

    a. Topographic Variables: (GIS Layers)

        i. _____

            _____

        ii. _____

            _____

        iii. _____

            _____

        iv. _____

            _____

        v. _____

            _____

        vi. _____

            _____

    b. Soil-Attribute Variables: (GIS Layers)

        i. _____

            _____

        ii. _____

            _____

        iii. _____

            _____

        iv. _____

            _____

    c. Water Resource Variables: (GIS Layers)

     i. _____

      _____

    ii. _____

      _____

   iii. _____

      _____

   iv. _____

      _____

    v. _____

      _____

d. Vegetation Variables: (GIS Layers)

     i. _____

      _____

    ii. _____

      _____

   iii. _____

      _____

   iv. _____

      _____

e. Social Factors: "Least Cost Path" to water resource for instance. (GIS Layers)

     i. _____

      _____

    ii. _____

      _____

   iii. _____

      _____

7) Has the CRPM been validated?

    a. Yes (If yes, please describe process used), include (%) percent accuracy if available.

_____

_____

_____

_____

_____

_____

    b. No

8) Has the CRPM program been included in your Programmatic Agreement (PA)?

    a. Yes

    b. No

9) SHPO concurrence on use?

    a. Yes

    b. No

10) What is the relationship with SHPO?

    a. Very Good

    b. Good

    c. Working

    d. Strained

11) What is the percent of installation currently surveyed?

    a. %:

12) Does the CRPM include any of the following components:

    a. Significance Model: Yes/No

        i. If yes, does it include subsurface testing for site Integrity aspect

          _____

          _____

          _____

          _____

    b. Geomorph Model: Yes/No

    c. Historic Model: Yes/No

13) Lessons Learned: Some ideas to consider: What would you do different? Issues you run into using CRPM? What works best for your cultural resource management program and how do you make it work well with the mission of your installation? What factors make a CRPM a value to the cultural resource program?

_____

_____

_____

_____

_____

_____

_____

Cultural Resource Predictive Modeling (CRPM) Survey

Sustainability and Environmental Group (SEG) Task-002

Range Commanders Council 2016

Installation Name: Barry M. Goldwater Range East (managed by US Air Force)

Address: 56th Range Management Office, 7101 N Jerstad Lane, Building 500, Luke AFB AZ 85309-1647

Person filing out survey form POC: Ms. Adrianne Rankin

Email: adrianne.rankin@us.af.mil   Phone: 623-856-8410

1) **Do you have Cultural Resource property to manage?**
   a. Yes **X**
   b. No (If No, survey complete)

2) **Do you use CRPM (Cultural Resource Predictive Modeling)**
   a. Yes   How Often:
   b. **No (Not Yet):** We are exploring how we can use data collected during our longitudinal Section 110 work to develop a comprehensive and representative understanding of the archaeology of the BMGR.

3) **What is the Program Name:**
   a. Software version: ArcGIS 10.3; R Statistical Package 3.2.3; ACDC v2 database (Microsoft Access 2007)
   b. Date implemented: in progress
   c. Software Architect: ESRI (ArcGIS) and SRI (ACDC v2)

4) **Subject Matter Expert (SME) for CRPM implementation/use.**

   a. Name: Christian Black

   b. Position: Geographer, 56 RMO/ESM

5) **Has a "Sampling Plan/Strategy" been used for model? (Prescribed burns for instance)**

   a. **Yes**, describe: ACDC v2 is being used to organize sites into types, according to function, chronology, and condition. The Luke AFB RMO GIS data will be used along with environmental strata to develop model training and test samples, according to site type and modeling unit. Survey has recently been completed in

upland areas of the BMGR E, providing important data in underrepresented environmental zones.

b. No

6) **Model Predictors (reference only)**

    a. Topographic Variables: (GIS Layers, including LiDAR – 8pts/sq. meter)

        i. shelter

        ii. relief

        iii. surface roughness/texture

        iv. aspect

        v. Slope; slope length

        vi. Elevation; standardized height; height above channel

    b. Soil-Attribute Variables: (GIS Layers)

        i. soil texture

        ii. depth to restrictive layer

        iii. CaCO3 content

        iv. organic matter content / A Horizon thickness

        v. Erosion potential (k factor, ERDEP)

        vi. Available water capacity

    c. Water Resource Variables: (GIS Layers)

        i. cost distance to drainage (major and minor); cost distance to Gila River; cost distance to Adair Bay

        ii. cost distance to springs, tinajas

        iii. flow accumulation

        iv. historic rainfall averages

    d. Vegetation Variables: (GIS Layers)

      i.   vegetation diversity within 1 km

     ii.   vegetation type

    iii.   surface visibility

e.   Social Factors: "Least Cost Path" to water resource for instance. (GIS Layers)

      i.   shell trade routes

     ii.   cost distance to lithic source materials (e.g., obsidian)

    iii.   least cost paths among major sites and resource zones

7) Has the CRPM been validated?

a.   Yes (If yes, please describe process used), include (%) percent accuracy if available.

b.   **No** (The CRPM is currently under development and has yet to be validated)

8) Has the CRPM program been included in your Programmatic Agreement (PA)?

a.   Yes

b.   **No,** but could be in the future as was recommended in *Pathways to Preservation: A Research Design and Heritage Management Plan for the Barry M. Goldwater Range, East* (Heilen and Vanderpot 2013).

9) SHPO concurrence on use?

a.   Yes

b.   **Not yet**

10) What is the relationship with SHPO?

a.   **Very Good**

b.   Good

c.   Working

d.   Strained

11) **What is the percent of installation currently surveyed?**
   a. 18%

12) **Does the CRPM include any of the following components:**
   a. Significance Model: **Yes**/No
      i. If yes, does it include subsurface testing for site Integrity aspect

         A draft significance model has been completed as part of *Pathways to Preservation: A Research Design and Heritage Management Plan for the Barry M. Goldwater Range, East* (Heilen and Vanderpot 2013). Relevant data for refining the model are available in ACDC and in existing GIS data. Subsurface testing is planned as part of model development and validation.
   b. Geomorph Model: **Yes**/No
      i. A buried sites model was recommended in the approach outlined in *Pathways to Preservation: A Research Design and Heritage Management Plan for the Barry M. Goldwater Range, East* (Heilen and Vanderpot 2013)
   c. Historic Model: Yes/**Not yet**, but historic contexts for ranching and military use have been developed or are under development, and these can be used along with archaeological discoveries to develop a historical-period model.

13) **Lessons Learned:** Some ideas to consider: What would you do different? Issues you run into using CRPM? What works best for your cultural resource management program and how do you make it work well with the mission of your installation? What factors make a CRPM a value to the cultural resource program?

Our Contractor in developing these tools, SRI, has learned that sampling areas that are not directly affected by training or development can be very important to building effective models. Moreover, performing subsurface testing and data recovery is important to

understanding and modeling site condition, significance, and integrity. CRPM is an important component when developing programmatic approaches to site and landscape management, and the 56 RMO/ESM is moving toward a programmatic approach.

Cultural Resource Predictive Modeling (CRPM) Survey

Sustainability and Environmental Group (SEG) Task-002

Range Commanders Council 2016

Installation Name: _NASA Wallops Flight Facility_____

Address: _34200 Fulton Street, Wallops Island, VA 23337_____

Person filing out survey form POC: _Shari Miller and Randy Stanley_____

Email: _Shari.A.Miller@nasa.gov & Randall.M.Stanley@nasa.gov

Phone: _757.824.2327 & 757.824.1309_____

1) **Do you have Cultural Resource property to manage?**
   a. (Yes)
   b. No (If No, survey complete)

2) **Do you use CRPM (Cultural Resource Predictive Modeling)**
   a. (Yes)   How Often: Once
   b. No (If No, please explain why you don't have one. Would you like to have one? Is there a shortage of resources? Do you not need CRPM?) (You are done with the survey if you answered "No".)

3) **What is the Program Name:**
   a. Software version: Not sure if this was software derived.
   b. Date implemented: November 2003
   c. Software Architect: As defined in NASA. (2003). *Final Cultural Resource Assessment of Wallops Flight Facility, Accomack County Virginia.* Lowery, D. L. 2003 *Archaeological Survey of the Atlantic Coast Shorelines Associated with Accomack County and Northampton Counties, Virginia.* Virginia Department of Historic Resources, Survey and Planning Report Series No. 7. Portsmouth, Virginia.

4) **Subject Matter Expert (SME) for CRPM implementation/use.**

   a. Name: Randy Stanley

   b. Position: Historic Preservation Officer

5) **Has a "Sampling Plan/Strategy" been used for model? (Prescribed burns for instance)**

   a. (Yes,) describe: _NASA WFF has established a Programmatic Agreement with the Virginia SHPO and ACHP which incorporates verifying the model through a Phase I Assessment is breaking ground in an area of moderate or high sensitivity.

   b. No

6) Model Predictors (reference only)

From Page 5-48: NASA. (2003). *Final Cultural Resource Assessment of Wallops Flight Facility, Accomack County Virginia.*

"The above model describes areas of moderate and high sensitivity for prehistoric archaeological resources. Low archaeological sensitivity areas include any of the following characteristics: poorly-drained soils (during prehistory); slopes greater than 10 percent; distances greater than 160 meters (500 feet) from water; and severe disturbance from modern activities, such as construction and earth-moving. The predictive model for prehistoric site locations within the current project area is summarized in Table 5-2."

Table 5-2. Prehistoric Site Predictive Model for the Project Area

Sensitivity	Landform	Soil Drainage Type	Slope	Distance to
Low	tidal marsh, topographically low areas	poorly-drained	< 2 %	n/a
	terrace, knoll, ridge, and bluff edges	all types	> 10 %	n/a
	terrace, knoll, ridge, bluff	all types	n/a	> 160 meters (> 500 feet)
Moderate	terrace, knoll, ridge, bluff, barrier island	moderately-drained	2 – 10 %	< 160 meters (< 500 feet)
High	terrace, knoll, ridge, bluff, barrier island	well-drained	2 – 10 %	< 160 meters (< 500 feet)
	hummock or knoll in tidal marsh	moderately- to well-drained	2 – 10 %	n/a

From Page 5-48: NASA. (2003). *Final Cultural Resource Assessment of Wallops Flight Facility, Accomack County Virginia.*

"The predictive models for historic site locations within the current project area are summarized in Tables 5-4 and 5-5."

Table 5-4. Non-Maritime Historic Site Predictive Model for the Project Area

Sensitivity	Landform	Soil Drainage Type	Slope	Distance to
Low	tidal marsh	poorly-drained	< 2 %	0
	terrace or bluff edge	all types	> 20 %	> 15 meters (> 50 feet)
Moderate	terrace, ridge, knoll	moderately to well-drained	10 – 20 %	n/a
High (all site types except mills)	terrace, ridge, knoll	well-drained	2 – 10 %	< 300 meters (< 900 feet)
High (mills only)	terrace or bluff edge adjacent to freshwater source	n/a	> 20 %	0

Domestic sites and cemeteries, as well as commercial and industrial sites such as taverns, tanneries, and mills, are included in the non-maritime sites. Low archaeological sensitivity areas include severe disturbance from modern activities, such as construction and earth-moving.

Table 5-5. Maritime Historic Site Predictive Model for the Project Area

Sensitivity	Landform	Soil Drainage Type	Slope	Distance to water
Low	terrace	all types	n/a	> 30 meters (> 100 feet)
Moderate	shoreline, tidal marsh, barrier island	poorly to moderately-drained	n/a	n/a
High (domestic[*])	barrier island	well-drained	> 2 % and < 10 %	< 30 meters (< 100 feet)
High (other than domestic)	barrier island, beach shoreline, tidal marsh	poorly to well-drained	n/a	< 30 meters (< 100 feet)

Note: Maritime sites include domestic sites such as fishing village communities

    a.   Topographic Variables: (GIS Layers)

          i.   see above

    b.   Soil-Attribute Variables: (GIS Layers)

          i.   see above

    c.   Water Resource Variables: (GIS Layers)

          i.   see above

    d. Vegetation Variables: (GIS Layers)

        i. <u>see above</u>

    e. Social Factors: "Least Cost Path" to water resource for instance. (GIS Layers)

        i. <u>see above</u>

7) Has the CRPM been validated?

    a. (Yes)(If yes, please describe process used), include (%) percent accuracy if available.

    <u>Model has been validated on a project specific basis only, i.e., if a project proposes to break ground in an area of increased sensitivity a Phase I Assessment is 1st performed.</u>

    b. No

8) Has the CRPM program been included in your Programmatic Agreement (PA)?

    a. (Yes)

    b. No

9) SHPO concurrence on use?

    a. (Yes)

    b. No

10) What is the relationship with SHPO?

    a. (Very Good)

    b. Good

    c. Working

    d. Strained

11) What is the percent of installation currently surveyed?

    a. 100% has been modelled.

12) Does the CRPM include any of the following components:

    a. Significance Model: Yes/No

        i. If yes, does it include subsurface testing for site Integrity aspect

        <u>Only if a project will break ground in a sensitive area.</u>

  b. Geomorph Model: Yes/No
  c. Historic Model: Yes/No

13) **Lessons Learned:** Some ideas to consider: What would you do different? Issues you run into using CRPM? What works best for your cultural resource management program and how do you make it work well with the mission of your installation? What factors make a CRPM a value to the cultural resource program?

NASA WFF has a dig request process for any ground breaking activities. The HPO and staff are tied into this process and can quickly determine if a proposal would occur in modelled areas. Additionally, all cultural sensitivity layers have been added to the GIS FlexFinal and are available to all PMs to reference. Having the SHPO's buy-in on the model made it much easier to get concurrence on the Programmatic Agreement.

Cultural Resource Predictive Modeling (CRPM) Survey

Sustainability and Environmental Group (SEG) Task-002

Range Commanders Council 2016

Installation Name: Aberdeen Proving Ground, MD

Address: _____

Person filing out survey form POC: Mark Gallihue, APG Cultural Resource SME

Email: mark.t.gallihue.civ@mail.mil Phone: _____

1) **Do you have Cultural Resource property to manage?**
   a. Yes

2) **Do you use CRPM (Cultural Resource Predictive Modeling)**
   a. No. APG does not have a formal CRPM. We do have a study that was done circa 1990s that developed a pseudo-model which we still use. That study produced GIS layers that show cemeteries, high potential archeological area, known disturbed archeological area, locally disturbed archeological area, historic districts, archeological sites, and historic ruins. The layers are interpreted along with other topographical features, such as distance to water, to make determinations on potential for cultural resources. This system has not been formally approved by the SHPO, but works well for management. Relationship with SHPO at APG is good to very good.

      One barrier to a computer model would be obtaining a certificate of net-worthiness from the NEC.

3) **What is the Program Name:**
   a. Software version:
   b. Date implemented:
   c. Software Architect:

4) **Subject Matter Expert (SME) for CRPM implementation/use.**

   a. Name:

   b. Position:

5) **Has a "Sampling Plan/Strategy" been used for model? (Prescribed burns for instance)**

   a. Yes,

      describe:_____

_____

_____

_____

_____

    b. No

6) Model Predictors (reference only)

    a. Topographic Variables: (GIS Layers)

        i. _____

          _____

        ii. _____

          _____

        iii. _____

          _____

        iv. _____

          _____

        v. _____

          _____

        vi. _____

          _____

    b. Soil-Attribute Variables: (GIS Layers)

        i. _____

          _____

        ii. _____

          _____

        iii. _____

          _____

        iv. _____

          _____

c. Water Resource Variables: (GIS Layers)

    i. _____

        _____

    ii. _____

        _____

    iii. _____

        _____

    iv. _____

        _____

    v. _____

        _____

d. Vegetation Variables: (GIS Layers)

    i. _____

        _____

    ii. _____

        _____

    iii. _____

        _____

    iv. _____

        _____

e. Social Factors: "Least Cost Path" to water resource for instance. (GIS Layers)

    i. _____

        _____

    ii. _____

        _____

    iii. _____

        _____

7) Has the CRPM been validated?

    a. Yes (If yes, please describe process used), include (%) percent accuracy if available.

_____

_____

_____

_____

_____

_____

    b. No

8) Has the CRPM program been included in your Programmatic Agreement (PA)?

    a. Yes

    b. No

9) SHPO concurrence on use?

    a. Yes

    b. No

10) What is the relationship with SHPO?

    a. Very Good

    b. Good

    c. Working

    d. Strained

11) **What is the percent of installation currently surveyed?**
    a. %:

12) **Does the CRPM include any of the following components:**
    a. Significance Model: Yes/No

        i. If yes, does it include subsurface testing for site Integrity aspect

        _____

        _____

        _____

        _____

    b. Geomorph Model: Yes/No
    c. Historic Model: Yes/No

13) **Lessons Learned:** Some ideas to consider: What would you do different? Issues you run into using CRPM? What works best for your cultural resource management program and how do you make it work well with the mission of your installation? What factors make a CRPM a value to the cultural resource program?

    _____

    _____

    _____

    _____

    _____

    _____

    _____

Cultural Resource Predictive Modeling (CRPM) Survey

Sustainability and Environmental Group (SEG) Task-002

Range Commanders Council 2016

Installation Name: _____*NAS Patuxent River*_____

Address: _____*Patuxent River, Maryland*_____

Person filing out survey form POC: _____*Michael A. Smolek, Cultural Resources Program Manager, NAS Patuxent River (NAVFAC)*

Email: _*Michael.a.smolek@navy.mil*___*Phone: 301-757-4774*

1) **Do you have Cultural Resource property to manage?**
    a. *Yes*
    b. No (If No, survey complete)

2) **Do you use CRPM (Cultural Resource Predictive Modeling)**
    a. Yes   How Often:
    b. *No* (If No, please explain why you don't have one. Would you like to have one? Is there a shortage of resources? Do you not need CRPM?) (You are done with the survey if you answered "No".) *A predictive model for prehistoric archaeological resources was developed in 2003 for the main base (6,500acres). Since that time approximately 90% of the surveyable terrestrial areas of the NAS Patuxent River Complex (some 20,000 acres) have been surveyed. The areas of the water ranges have not been systematically surveyed. The model was developed before the current CRM was employed here.*

3) **What is the Program Name:**
    a. Software version: *unknown*
    b. Date implemented: *2003*
    c. Software Architect: *Eagan, McAllister Associates, Inc*.

4) **Subject Matter Expert (SME) for CRPM implementation/use.**

    a. Name: *none*

    b. Position:

5) **Has a "Sampling Plan/Strategy" been used for model? (Prescribed burns for instance)**

    a. Yes,

    describe:_*No*_____

    _____

_____

_____

_____

b. No

6) Model Predictors (reference only)

    a. Topographic Variables: (GIS Layers)

        i.   *soils*_____

            _____

        ii.   *proximity to water*_____

        iii.   *elevation*_____

        iv.   *slope*_____

            _____

        v.   *aspect*   *(eastern or southern exposure)*_____

        vi.   _____

            _____

    b. Soil-Attribute Variables: (GIS Layers)

        i.   *Existing sites were correlated with six different soil types as defined by County Soil Conservation Service mapping-which considers many variables to define soil type*

            _____

        ii.   _____

            _____

        iii.   _____

            _____

        iv.   _____

            _____

    c. Water Resource Variables: (GIS Layers)

      i. _____ *Greater or less than 400 feet from water (fresh and brackish)_____*

      ii. _____

          _____

      iii. _____

          _____

      iv. _____

          _____

      v. _____

          _____

d. Vegetation Variables: (GIS Layers)

      i. _____ *Not considered_____*

      ii. _____

          _____

      iii. _____

          _____

      iv. _____

          _____

e. Social Factors: "Least Cost Path" to water resource for instance. (GIS Layers)

      i. ____ *Not considered because not really relevant in coastal plain environment with plentiful water and few barriers*

      ii. _____

          _____

      iii. _____

          _____

7) Has the CRPM been validated?

    a. Yes (If yes, please describe process used), include (%) percent accuracy if available.

        _____*No*_____

        _____

        _____

        _____

        _____

    b. No

8) Has the CRPM program been included in your Programmatic Agreement (PA)?

    a. Yes

    b. No, *we have no programmatic agreement for this concern*

9) SHPO concurrence on use?

    a. Yes

    b. No *Unknown, but generally SHPO doesn't put much faith in predictive models at the current time.*

10) What is the relationship with SHPO?

    a. *Very Good*

    b. Good

    c. Working

    d. Strained

11) **What is the percent of installation currently surveyed?**
    a.   %: *92% of the installation that the model was based upon*

12) **Does the CRPM include any of the following components:**
    a. Significance Model: Yes*/No*

         i. If yes, does it include subsurface testing for site Integrity aspect

          _____

          _____

          _____

          _____

    b. Geomorph Model: Yes/No

    c. Historic Model: Yes/*No*

13) **Lessons Learned:** Some ideas to consider: What would you do different? Issues you run into using CRPM? What works best for your cultural resource management program and how do you make it work well with the mission of your installation? What factors make a CRPM a value to the cultural resource program? *If there is an undertaking proposed in an unsurveyed area, generally a survey is required, model or no model. So the model may be useful in some situations, it is not particularly useful in our situation. The model also only deals with Native American archaeological sites, so the 350+ years of historic period Euro-American occupation is not considered and, in any case, is more difficult to model. The model does not deal with the huge areas of the Chesapeake Bay or Atlantic Ranges, which are water ranges with the potential for historic and prehistoric sites.*

_____

_____

_____

_____

_____

_____

_____

CRPM Survey Questions

SEG-002

Range Commanders Council 2016

Installation Name: Edwards Air Force Base

Address: 120 N Rosamond Blvd Bldg 3735 Edwards AFB CA 93524

Person filing out survey form POC: Roscoe Loetzerich

Email: roscoe.loetzeric.1@us.af.mil   **Phone:** (661) 277-1413

1) Do you have Cultural Resource property to manage?
   a. Yes
   b. No (If No, survey complete)

2) Do you use CRPM (Cultural Resource Predictive Modeling)
   a. Yes   How Often: once per year
   b. No (If No, survey complete)

3) What is the Program Name: ArcGIS
   a. Software version: 10.3
   b. Date implemented: circa 2004
   c. Software Architect:

4) SME for CRPM implementation/use.

   a. Name: Roscoe Loetzerich

   b. Position: Base Archaeologist

5) Has a "Sampling Plan/Strategy" been used for model? (Prescribed burns for instance)

   a. Yes, describe: Stratified Random Sample of 460 ¼ Sections located in the southwest quarter of each one square mile Section on Edwards AFB. The number and quantity of acreage per Sample Survey Unit (1/4 square mile) is known across the entire base allowing the base archaeologist to interpolate the number or sites or the acres of site per adjoining area to an SSU.

   b. No

6) Model Predictors (reference only)

   a. Topographic Variables: (GIS Layers)

CRPM Survey Questions

SEG-002

Range Commanders Council 2016

    i. Archaeological survey layer

_____

    ii. Archaeological site layer Archaeological site feature

_____

    iii. Sample Survey

        feature_____

    iv. _____

_____

b. Soil-Attribute Variables: (GIS Layers)

    i. N/A_____

_____

    ii. _____

_____

    iii. _____

_____

    iv. _____

_____

c. Water Resource Variables: (GIS Layers)

    i. N/A_____

_____

    ii. _____

_____

    iii. _____

_____

    iv. _____

_____

    v. _____

_____

    d. Vegetation Variables: (GIS Layers)

        i. N/A_____

          _____

        ii. _____

          _____

        iii. _____

          _____

        iv. _____

          _____

    e. Social Factors: "Least Cost Path" to water resource for instance. (GIS Layers)

        i. N/A_____

          _____

        ii. _____

          _____

        iii. _____

          _____

7) Has the CRPM been validated?

    a. Yes (If yes, please describe process used), include (%) percent accuracy if available.

        _____

        _____

        _____

        _____

        _____

        _____

    b. No

8) Has the CRPM program been included in PA?

    a. Yes

    (b.) No

9) SHPO concurrence on use?

    a. Yes

    (b.) No

10) What is the relationship with SHPO?

    a. Very Good

    b. Good

    (c.) Working

    d. Strained

11) What is the percent of installation currently surveyed?

    a. Approximately 70%:

12) Does the CRPM include any of the following components:

    a. Significance Model: Yes/(No)

        i. If yes, does it include subsurface testing for site Integrity aspect

        _____

        _____

        _____

        _____

    b. Geomorph Model: Yes/(No)

    c. Historic Model: Yes/(No)

13) Lessons Learned: What would you do different?

Predictive modeling based on environmental variables (landforms, distance to water source, slope, aspect, vegetation, etc.) is useful for bases with very large tracts of land with a high degree of environmental heterogeneity. Obviously the more similar the environment is across the base with no major differences in vegetation, soil types, etc, the less beneficial a predictive model will be. Edwards AFB is by and large a fairly homogenous base. Furthermore, while the base has current environmental data, it lacks GIS layers that represent soil, vegetation, or hydrographical layers for the recent and distant past making predictions of site types for specified periods of time in relation to environmental variables basically impossible to determine.

Recognizing this shortcoming it was decided to focus on the physical archaeological survey of the base. A five year project was launched in 1999 to conduct a 25% sample of the base resulting in the survey of the southwest quarter of each one square mile USGS Section across the base. From this data it is possible to estimate the number of acres of archaeological site between the ¼ mile quarter sections.

The cultural resource program is well into its 3rd decade of existence. Hundreds of Federal undertakings have resulted in additional surveys being performed so that currently approximately 70% of the base been inventoried for archaeological resources. This wealth of survey data is often consulted in those cases where a need exists to predict the potential to encounter an archaeological site in previously uninvestigated portion of the base.

If a graphic is needed to demonstrate the predicted density of archaeological sites in an area, this is most commonly achieved by creating a density map. The density map is calculated by establishing a point at the center of each of the Sample Survey Units. The total acreage of archaeological site is calculated for the unit and the number is associated with the center point. The ArcGIS software includes a tool to generate

contour lines based on the value of each center point. The ArcGIS technician then enters the number of contour lines to generate between values. The area between the contour lines essentially represents the expected acreage, expressed as a range, of archaeological site to expect within that band.

This is a very straight-forward and simple model, but it is based on reliable data and commensurate with the environment found at Edwards AFB. Given the large body of data currently available there is no limit to the number of academic models that could be developed, but they are not an immediate requirement for the day-to-day management of the resource. That said, the base is always interested in pursuing or supporting models that can help explain the archaeological sites and their distribution across the base.

CRPM Survey Questions

RCC Approved Task: SEG-002

Range Commanders Council 2016

Installation Name: WHITE SANDS Missile RANGE

Address: WSMR, B 163, NEW MEXICO 88002

Person filing out survey form POC: Jim Bowman

Email: JAMES.e.bowman68.21u@ MAIL.MIL **Phone:** 575-678-7925

1) Do you have Cultural Resource property to manage?
   - (a.) Yes
   - b. No (If No, survey complete)

2) Do you use CRPM (Cultural Resource Predictive Modeling)
   - (a.) Yes   How Often: 2x per YEAR
   - b. No (If No, survey complete)

3) What is the Program Name: ARC GIS
   - a. Software version: MARCH 2012
   - b. Date implemented: 2001
   - c. Software Architect: (SRI) STATISTICAL RESEARCH, INC TUCSON AZ

4) SME for CRPM implementation/use.
   - a. Name: Jim Bowman
   - b. Position: ARCHaeoLogist

5) Has a "Sampling Plan/Strategy" been used for model? (Prescribed burns for instance)
   - (a.) Yes, describe: _Prescribed Burns on WSMR_
     _____
     _____
     _____
     _____
   - b. No

6) Model Predictors (reference only)

    a. Topographic Variables: (GIS Layers)

        i. SLOPE: (% slope or Deg slope)

        ii. Cost Surface: Relative cost of moving across landscape.

        iii. ASPECT: Direction in which a slope is facing.

        iv. Terrain Roughness: Surface Texture.

        v. Shelter: Degree to which Topographic Features afford shelter.

        vi. Cost Distance To uplands: (Euclidean path)

    b. Soil-Attribute Variables: (GIS Layers)

        i. SOIL SURVEY GEOGRAPHIC (SSURGO) 1:24,000 (organic matter, available water

        ii. capacity, Bulk Density etc...)

        iii. _____

        iv. _____

    c. Water Resource Variables: (GIS Layers)

        i. LANDSCAPE FEATURES THAT could HAVE PROVIDED SURFACE WATER Resources AFTER Precipitation EPISODES.

    ii. <u>DISTANCE TO TANKS: LOCATIONS OF ARTIFICIAL TANKS FOR WATER STORAGE (EUCLIDEAN DISTANCE)</u>

    iii. <u>DISTANCE TO STREAMLINES: DISTANCE TO DRAINAGES (EUCLIDEAN DISTANCE)</u>

    iv. <u>ELEVATION RELATIVE TO WATER:</u>

    v. _____

d. Vegetation Variables: (GIS Layers)

    i. <u>DATA FROM GAP ANALYSIS PROGRAM; a NATIONAL LAND COVER DATA PROGRAM</u>

    ii. _____

    iii. _____

    iv. _____

e. Social Factors: "Least Cost Path" to water resource for instance. (GIS Layers)

    i. <u>CALCULATION of "LEAST COST PATH" FOR WATER (EUCLIDEAN DISTANCE)</u>

    ii. _____

    iii. _____

CRPM Survey Questions

RCC Approved Task: SEG-002

Range Commanders Council 2016

7) Has the CRPM been validated?

    a. Yes (If yes, please describe process used), include (%) percent accuracy if available.

        <u>   No   </u>

    b. No

    c. Estimate the approximate cost to date that has been spent on CRPM?

        <u> $150,000   </u>

    d. Estimate future cost per year of maintenance/data entry, required for system viability.

        <u> $25,000.00   </u>

    e. What are the manpower requirements for system maintenance?

        <u>1 GIS Technician half time</u>

8) Has the CRPM program been included in PA?

    a. Yes

    (b.) No

9) SHPO concurrence on use?

    a. Yes

    (b.) No

CRPM Survey Questions

RCC Approved Task: SEG-002

Range Commanders Council 2016

10) What is the relationship with SHPO?

    (a.) Very Good

    b. Good

    c. Working

    d. Strained

11) What is the percent of installation currently surveyed?

    a. %: 28

12) Does the CRPM include any of the following components:

    a. Significance Model: Yes/(No)

        i. If yes, does it include subsurface testing for site Integrity aspect

        _____

        _____

        _____

        _____

    b. Geomorph Model: Yes/(No)

    c. Historic Model: Yes/(No)

13) Lessons Learned: What would you do different, Is it helpful, Is it useful?

It works well on inaccessible areas where survey can be focused on a sample of areas.

Cultural Resource Predictive Modeling (CRPM) Survey

Sustainability and Environmental Group (SEG) Task-002

Range Commanders Council 2016

Installation Name: ___Naval Undersea Warfare Center Division, Keyport___

Address: ___610 Dowell St, Keyport WA 98345___

Person filing out survey form POC: ___Brian Adams___

Email: ___brian.s.adams@navy.mil___   **Phone:** ___360-315-3321___

1) **Do you have Cultural Resource property to manage?**
   a. Yes
   b. No (If No, survey complete) ✔

2) **Do you use CRPM (Cultural Resource Predictive Modeling)**
   a. Yes   How Often:
   b. No (If No, please explain why you don't have one. Would you like to have one? Is there a shortage of resources? Do you not need CRPM?) (You are done with the survey if you answered "No".)

3) **What is the Program Name:**
   a. Software version:
   b. Date implemented:
   c. Software Architect:

4) **Subject Matter Expert (SME) for CRPM implementation/use.**

   a. Name:

   b. Position:

5) **Has a "Sampling Plan/Strategy" been used for model? (Prescribed burns for instance)**
   a. Yes,

      describe:_____

      _____

      _____

      _____

      _____

   b. No

6) **Model Predictors (reference only)**

    a. Topographic Variables: (GIS Layers)

        i. _____

            _____

        ii. _____

            _____

        iii. _____

            _____

        iv. _____

            _____

        v. _____

            _____

        vi. _____

            _____

    b. Soil-Attribute Variables: (GIS Layers)

        i. _____

            _____

        ii. _____

            _____

        iii. _____

            _____

        iv. _____

            _____

    c. Water Resource Variables: (GIS Layers)

        i. _____

            _____

        ii. _____

            _____

      iii. _____

           _____

      iv. _____

           _____

      v. _____

           _____

d. Vegetation Variables: (GIS Layers)

      i. _____

           _____

      ii. _____

           _____

      iii. _____

           _____

      iv. _____

           _____

e. Social Factors: "Least Cost Path" to water resource for instance. (GIS Layers)

      i. _____

           _____

      ii. _____

           _____

      iii. _____

           _____

7) Has the CRPM been validated?

    a. Yes (If yes, please describe process used), include (%) percent accuracy if available.

    _____

    _____

    _____

    _____

    _____

    _____

    b. No

8) Has the CRPM program been included in your Programmatic Agreement (PA)?

    a. Yes

    b. No

9) SHPO concurrence on use?

    a. Yes

    b. No

10) What is the relationship with SHPO?

    a. Very Good

    b. Good

    c. Working

    d. Strained

11) What is the percent of installation currently surveyed?
    a. %:

12) Does the CRPM include any of the following components:
    a. Significance Model: Yes/No

        i. If yes, does it include subsurface testing for site Integrity aspect

          _____

          _____

          _____

          _____

    b. Geomorph Model: Yes/No
    c. Historic Model: Yes/No

13) Lessons Learned: Some ideas to consider: What would you do different? Issues you run into using CRPM? What works best for your cultural resource management program and how do you make it work well with the mission of your installation? What factors make a CRPM a value to the cultural resource program?

_____

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Cultural Resource Predictive Modeling (CRPM) Survey

Sustainability and Environmental Group (SEG) Task-002

Range Commanders Council 2016

Installation Name: __NAVAIR China Lake Ranges

_____

Address: ___NAWS China Lake, CA

_____

Person filing out survey form POC: ___Steve Pennix

_____

Email: _____steve.penix@navy.mil_____Phone: __760-939-6026_____

1) **Do you have Cultural Resource property to manage?**
   a. Yes- **YES**
   b. No (If No, survey complete)

2) **Do you use CRPM (Cultural Resource Predictive Modeling)**
   a. Yes   How Often:
   b. No (If No, please explain why you don't have one. Would you like to have one? Is there a shortage of resources? Do you not need CRPM?) (You are done with the survey if you answered "No".) **NO: We are in the process of developing a CRPM right now. Predicted to be completed in the next two years.**

3) **What is the Program Name:**
   a. Software version:
   b. Date implemented:
   c. Software Architect:

4) **Subject Matter Expert (SME) for CRPM implementation/use.**

   a. Name:

   b. Position:

5) **Has a "Sampling Plan/Strategy" been used for model? (Prescribed burns for instance)**

   a. Yes,

   describe:_____

   _____

   _____

_____

_____

b. No

6) Model Predictors (reference only)

    a. Topographic Variables: (GIS Layers)

        i. _____

               _____

        ii. _____

               _____

        iii. _____

               _____

        iv. _____

               _____

        v. _____

               _____

        vi. _____

               _____

    b. Soil-Attribute Variables: (GIS Layers)

        i. _____

               _____

        ii. _____

               _____

        iii. _____

               _____

        iv. _____

               _____

    c. Water Resource Variables: (GIS Layers)

     i. _____

     ii. _____

     iii. _____

     iv. _____

     v. _____

d. Vegetation Variables: (GIS Layers)

     i. _____

     ii. _____

     iii. _____

     iv. _____

e. Social Factors: "Least Cost Path" to water resource for instance. (GIS Layers)

     i. _____

     ii. _____

     iii. _____

7) **Has the CRPM been validated?**

    a. Yes (If yes, please describe process used), include (%) percent accuracy if available.

    _____

    _____

    _____

    _____

    _____

    _____

    b. No

8) **Has the CRPM program been included in your Programmatic Agreement (PA)?**

    a. Yes

    b. No

9) **SHPO concurrence on use?**

    a. Yes

    b. No

10) What is the relationship with SHPO?

    a. Very Good

    b. Good

    c. Working

    d. Strained

11) **What is the percent of installation currently surveyed?**
   a. %:

12) **Does the CRPM include any of the following components:**
   a. Significance Model: Yes/No
      i. If yes, does it include subsurface testing for site Integrity aspect

      _____

      _____

      _____

      _____

   b. Geomorph Model: Yes/No
   c. Historic Model: Yes/No

13) **Lessons Learned:** Some ideas to consider: What would you do different? Issues you run into using CRPM? What works best for your cultural resource management program and how do you make it work well with the mission of your installation? What factors make a CRPM a value to the cultural resource program?

   _____

   _____

   _____

   _____

   _____

   _____

   _____

Cultural Resource Predictive Modeling (CRPM) Survey

Sustainability and Environmental Group (SEG) Task-002

Range Commanders Council 2016

Installation Name: _____ Naval Base Ventura County, San Nicolas Island _____

Address: _____ 575 I Ave., Building 53, Point Mugu, CA, _____

Person filing out survey form POC: _Lisa Thomas_____

Email: _____ Lisa.Thomas@Navy.Mil _____ **Phone:** ___ 805-989-1938 ____

1) **Do you have Cultural Resource property to manage?**
   a. Yes   X
   b. No (If No, survey complete)

2) **Do you use CRPM (Cultural Resource Predictive Modeling)**
   a. Yes   How Often:
   b. No (If No, please explain why you don't have one. Would you like to have one? Is there a shortage of resources? Do you not need CRPM?) (You are done with the survey if you answered "No".) No. San Nicolas Island has had a %100 survey for archaeological sites, completed in 1998. Areas on the West End that are composed of heavy sand dune deposits are assumed to contain buried sites and are addressed accordingly.

3) **What is the Program Name:**
   a. Software version:
   b. Date implemented:
   c. Software Architect:

4) **Subject Matter Expert (SME) for CRPM implementation/use.**

   a. Name:

   b. Position:

5) **Has a "Sampling Plan/Strategy" been used for model? (Prescribed burns for instance)**

   a. Yes,

   describe:_____

   _____

   _____

   _____

   _____

   b. No

6) Model Predictors (reference only)

    a. Topographic Variables: (GIS Layers)

        i. _____

        _____

        ii. _____

        _____

        iii. _____

        _____

        iv. _____

        _____

        v. _____

        _____

        vi. _____

        _____

    b. Soil-Attribute Variables: (GIS Layers)

        i. _____

        _____

        ii. _____

        _____

        iii. _____

        _____

        iv. _____

        _____

    c. Water Resource Variables: (GIS Layers)

        i. _____

        _____

        ii. _____

        _____

      iii. _____

           _____

      iv. _____

           _____

      v. _____

           _____

d. Vegetation Variables: (GIS Layers)

      i. _____

           _____

      ii. _____

           _____

      iii. _____

           _____

      iv. _____

           _____

e. Social Factors: "Least Cost Path" to water resource for instance. (GIS Layers)

      i. _____

           _____

      ii. _____

           _____

      iii. _____

           _____

7) Has the CRPM been validated?

    a. Yes (If yes, please describe process used), include (%) percent accuracy if available.

    _____

    _____

    _____

    _____

    _____

    _____

    b. No

8) Has the CRPM program been included in your Programmatic Agreement (PA)?

    a. Yes

    b. No

9) SHPO concurrence on use?

    a. Yes

    b. No

10) What is the relationship with SHPO?

    a. Very Good

    b. Good

    c. Working

    d. Strained

11) **What is the percent of installation currently surveyed?**
    a. %:

12) **Does the CRPM include any of the following components:**
    a. Significance Model: Yes/No

        i. If yes, does it include subsurface testing for site Integrity aspect

        _____

        _____

        _____

        _____

    b. Geomorph Model: Yes/No
    c. Historic Model: Yes/No

13) **Lessons Learned:** Some ideas to consider: What would you do different? Issues you run into using CRPM? What works best for your cultural resource management program and how do you make it work well with the mission of your installation? What factors make a CRPM a value to the cultural resource program?

    _____

    _____

    _____

    _____

    _____

    _____

    _____

Appendix C

Citations

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Appendix D

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